Denaturation of whey proteins of milk during ohmic heating

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Ohmic heating is receiving increasing attention from the dairy industry, once it is considered to be an alternative for the indirect heating methods of milk pasteurization. Milk proteins are probably the most affected constituents by heating and some of the changes may involve interaction with sugars, aggregation of casein micelles or association of whey protein aggregates with casein micelle surface through formation of the β-lactoglobulin - κ-casein complex. However, very limited information is available on the effects that the presence of moderate electric fields during heating may have on denaturation processes of milk proteins. The aim of this work is to evaluate the denaturation of the main whey proteins of bovine milk during ohmic heating. Raw bovine milk samples were heated at different temperatures (75, 80 and 85 ºCC) using different heating rates and holding times (up to 30 minutes). Ohmic heating experiments were also adapted to simulate the sample temperature changes during conventional (indirect heating) experiments. Micro-differential scanning calorimetry (micro-DSC) was used to determine denaturation level and denaturing temperatures of the main whey proteins of bovine milk, such as β-lactoglobulin and α-lactalbumin, by means of thermal analysis. Non-denaturating gel electrophoresis was also applied in order to detect any changes on the charge and hydrodynamic size of proteins. Our results show that the presence of moderate electric fields during heating, when compared with conventional heating experiments, did not enhance protein denaturation. Two endothermic peaks were found in micro-DSC heating curves of samples subjected to the ohmic heating treatment at 85 ºCC during 30 s; thermal transitions were observed at 41ºCC and 71ºCC eventually corresponding to the denaturation of α-lactalbumin and β-lactoglobulin, respectively. Native electrophoretic bands also revealed that most of α-lactalbumin and β-lactoglobulin changed to a denatured state after heating treatments of up to 15 minutes at 85 ºCC.